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THE GLASS INDUSTRY

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THE DEVELOPMENT OF A MODERN COLORED GLASS

In 1928 a prominent manufacturer of pot-glass tableware gave the problem of producing a pure yellow glass to the late A. R. Payne and the writer. Almost every author writing on the subject of yellow glass emphasized the difficulty of producing it. It had been found difficult to successfully control the oxidation-reduction equilibrium during melting. Each new pot of glass produced became a separate problem in itself. The glass that this manufacturer wanted, to be successful, had not only to have the proper color, but that the color had to be uniform from pot melt to pot melt. The glass had to be easily worked, and not too expensive.

The available literature on the subject at this time was carefully perused and practically everything that was mentioned was used in trial melts of ten pounds each. Iron oxide-manganese dioxide, uranium oxide, uranium oxide-manganese dioxide, cerium dioxide, titanium dioxide, sulphur, sulphur-carbon, cadmium sulphide, sodium sulphide, iron sulphide and carbon were all tried without marked success. Uranium oxide gave the most promise of the various combinations tried, but with the yellow color by transmitted light a fluorescent green color by reflected light was produced. A very pleasing yellow color was made by uranium oxide in a lead glass without the green fluorescence, but the lead oxide content of the glass had to be carried as high as 40 per cent before the green fluorescence could be eliminated. The high lead oxide content of this glass made it very expensive, and was quite corrosive on the glass melting pots. This glass was not suitable for pressed-table-glassware because of its weight and cost.

In one of the experimental melts both cerium dioxide and titanium dioxide had been used, and a surprising muddy yellow color developed. In previous melts when cerium dioxide and titanium dioxide had been used separately only a slight coloration had developed. Several pounds of chemically pure cerium nitrate and a very pure titanium dioxide were obtained and a new melt made. The color proved to be excellent and constant on successive meltings. The cost was prohibitive as chemically pure cerium nitrate was selling for from $4.50 to $5.00 per pound at this time. The coloring power of the cerium dioxide-titanium dioxide combination is comparatively low and several per cent of each must be present in the glass before any appreciable depth of color can be obtained, and in these quantities very soon runs into money.

The search for a pure and reasonably cheap cerium compound was long and laborious. Cerium is found chiefly in Cerite and Monazite sand. Cerite usually contains cerium, lanthanum, neodymium and praseodymium as silicates. Monazite sand contains cerium and the other rare earth elements with thorium as phosphates. The Monazite sand had been extracted chiefly for its thorium content, used in the manufacture of incandescent gas mantles. The cerium was not completely separated from the other rare earth elements and was marketed as rare earth hydrate, didymium oxide and as a commercial cerium hydrate. The purest of this cerium hydrate was procured and used with a known high purity titanium dioxide in several melts. The glasses were all of a dirty yellow color showing that the cerium hydrate carried impurities too high in the content of the other rare earth elements. The manufacturers of cerium hydrate collaborating in this work undertook to make a more pure product. Finally, after much labor and experimentation an almost chemically pure cerium hydrate was produced which proved successful in making yellow glass. The price of this product, while still relatively high, was judged low enough by the management of the glass plant to be used in glass manufacture. The separation of the rare earth elements from one another is one of the most difficult in inorganic chemistry, especially on a commercial scale. The other rare earth elements found with cerium even when found in small quantities, ruin the bright yellow color of the glass by producing complementary or interfering colors giving a muddy effect.

Neither cerium dioxide nor titanium dioxide separately in pure form imparts any marked color to a soda lime glass. The yellow color is possibly produced by the interaction of different coloring ions upon one another as suggested by Weyl in the May, 1937, issue of THE GLASS INDUSTRY in the article, "The Chemistry of Colored Glass." S. R. Scholes, in "Modern Glass Practice," suggests the possible formation of cerium titanate and offers the opinion that there might be a partition of cerium between silica and titania, which is carried to the titania side with greater concentration of the latter. This idea may have possibilities, as titanium containing compounds have been found in natural deposits of igneous rocks formed at high temperatures. Titanite, calcium titanium silicate ($CaTiSiO_5$), the calcium salt of dimetasilic acid ($H_2Si_2O_5$), in which titanium has replaced one silicon atom is an example. Cerium always behaves as a basic element, and there is some possibility that cerium titanium silicate [$Ce(TiSiO_5)_2$] might be formed when melting glass with these elements present. There is also the possibility of the formation of a cerium titanium compound such as [$Ce(Ti_2O_5)_2$], where titanium has replaced all of the silicon from [$Ce(TiSiO_5)_2$]. The yellow color might possibly be developed without the silicon entering into the reaction. Cerium could possibly combine with the titanium in the glass as cerium titanate

$[Ce(TiO_3)_2]$. When more titanium is present than is necessary to satisfy the cerium in this combination the $[Ce(Ti_2O_5)_2]$ might develop.

When 2.6 percent cerium dioxide and 2.4 percent titanium dioxide by weight are present in a soda lime glass a very pleasing yellow color is produced. The ratio of cerium dioxide to titanium dioxide in this glass is almost exactly the same as the ratio by weight in which they are found in the not impossible compounds $(Ce(TiSiO_5)_2)$ and $[Ce(TiO_3)_2]$. If the titanium dioxide content of the glass is held constant at 2.4 percent by weight, and the cerium dioxide content gradually increased above 2.6 per cent by weight, only a slight increase in color intensity will be observed. However, if the cerium dioxide content of the glass is held constant at 2.6 percent by weight and the titanium dioxide percentage by weight increased gradually above 2.4 percent a marked and uniform increase in color density will be observed until approximately 5.5 percent by weight titanium dioxide has been reached. Above 5.5 percent the increase in color will be slight for further additions of titanium dioxide. The ratio of 2.6 percent cerium dioxide and 5.5 percent titanium dioxide by weight in the glass gives a very close approximation of the ratio by weight found for cerium dioxide and titanium dioxide in the suggested compound $[Ce(Ti_2O_5)_2]$ where titanium has completely replaced silicon from $[Ce(TiSiO_5)_2]$. The same color density as that of 2.6 percent cerium dioxide and 5.5 percent titanium dioxide by weight can be produced by using 3.8 percent cerium dioxide and 3.6 percent titanium dioxide by weight and this is the same ratio of cerium dioxide to titanium dioxide by weight as would be found in the combinations $[Ce(TiO_3)_2]$ and $[Ce(TiSiO_5)_2]$. This possibly indicates that the coloring powers of the cerium titanate $[Ce(TiO_3)_2]$ and the cerium titanium silicate $[Ce(TiSiO_5)_2]$ are about two-thirds as strong as when the cerium is in combination with a higher concentration of titanium as suggested by $[Ce(Ti_2O_5)_2]$.

While the compounds suggested as formed by cerium with dimetasilicic acid and the titanium combinations are used as examples, the cerium could possibly be held in combination in some other form of titanium silicate or titanium compound. Whatever form this might be there seems to be a definite relation of one atom of cerium with either two or four atoms of titanium in the color formations, and that the maximum color density is obtained when the ratio is one to two of cerium dioxide to titanium dioxide by weight in a soda lime glass.

CORNING ERECTS TWO NEW BUILDINGS

Further expansion of Corning Glass Works, Corning, N. Y., the largest increase in production capacity in many years, has been announced by Amory Houghton, president of the company. The two buildings, which are to be constructed, consist of a 200,000 square foot floor space building for production in two stories north of the Fall Brook fibre products plant, and a new four story laboratory building to replace two old buildings in the main plant. The new plant north of Fall Brook will be used for the manufacture and storage of pressed ware, such as baking ware, nursing bottles, fuse plugs and other promising lines still in the development stage.

Program Announced for Glass Division Meeting

The program for the Summer Meeting of the Glass Division has just been completed, and is announced as follows:

Friday, September 10.

I. New Developments and Ideas in Analytical Chemistry of Interest to the Glass Industry. Dr. G. E. F. Lundell, Principal Chemist, National Bureau of Standards.

II. Developments in the Concepts of the Constitution of Glass. Dr. N. W. Taylor, Department of Ceramics, Pennsylvania State College.

III. A Critical Summary of the Results of X-ray Studies of Glass. Dr. B. E. Warren, Department of Physics, Massachusetts Institute of Technology.

IV. 12:30 P.M. Lunch.

V. 2:30 P.M. Inspection of Ceramic and Other Laboratories of Pennsylvania State College.

Saturday, September 11.

VI. The Mechanical Properties of Glass; Their Significance and Determination. Dr. G. W. Morey, Geophysical Laboratory, and Dr. Louis Navias, General Electric Co.

VII. 12:30 P.M. Lunch, to be followed by committee meetings, golf or tennis as the occasion demands or permits.

It will be noted that the program differs materially from the type arranged in recent years. Heretofore, quite a number of short papers havze been presented and there has not been time for adequate discussion. This year the meeting will consist almost of a round table discussion, with topics assigned to designated leaders. It is felt that the new procedure will have the effect of putting on an organized basis those informal gatherings and discussions which have been such an outstanding feature of this mid-year conference.

Headquarters for the Summer Meeting will be at the Nittany Lion Inn, State College, Pa. Friday's session will be called to order at 9:30, and Saturday's at 9:00 o'clock, Eastern Standard Time. A special program of entertainment is being formulated and will be announced later. Individual hotel reservations should be made well in advance, preferably at once.

FELDSPAR SALES INCREASE IN 1936

The feldspar industry in 1936 produced more spar than in any prior year, sales of crude surpassing the 1928 peak by 16 per cent, according to the U. S. Bureau of Mines, Department of the Interior. Sales of ground spar also reached a new high. Increased consumption of feldspar by the glass industry was largely responsible for both records. Among the more important developments during the year were the steadily increasing importance of western feldspar, the active research program sponsored by the National Feldspar Association, the rise of new competing materials such as nepheline syenite, and the extensive mechanical improvements to existing plants. Four new feldspar grinding mills were projected during 1936, three of them being either in operation at the end of the year or under construction with definite plans to start grinding operations during the early part of 1937.

BLANK DISTRIBUTION AND THE PENETRATION FACTOR

By GEORGE ROESSLER

From the inception of mechanized methods, the container industry has been seeking for a perfected technique for the designing of blank molds. Notwithstanding, designing must still be called nothing less than experimental or cut-and-fit. It is true that there are certain makeshift practices which are founded on long experience but these are scattered between the plants in a way which makes them unavailable as a general practice. This article attempts to point out methods for obtaining distribution in the blank mold wherein ductility, as described previously, plays an important role.

The present discussion relates to the behavior of melted glass in the blank mold at the time of the blow-back and to methods for designing molds to make full use of the ductility and penetration factors. It must be remembered throughout that ductility is the one and only characteristic of molten glass by which it can be formed or otherwise manipulated to make ware.

Before launching the more detailed description of the designing theory a brief outline of the blown-blown method will be set forth in order to give perspective as well as focus to the consideration of the utilization of ductility as a means for improving blank design.

Of all the major divisions of the process for forming glass articles the blown-blown method is probably the most important. It is the method whereby the blank or parison is pre-formed by inflating the glass in the blank mold as distinguished from those methods using a solid parison or a pressed, pre-formed shape. It finds a more general and successful application, than any other single method, in the forming of a wide range of hollow-ware items.

From the time that glass was blown by hand, glass-making has involved two distinct steps, the first comprising the making of a preliminary form, and the second the blowing or expanding of this form to the size and shape of the final ware. With the advent of mechanized means for forming glass these two steps were translated into various substituting mechanisms. Consequently, present forming methods include, first, a blank mold in which a preliminary formation is given the viscous glass, and second, a separate blow mold in which the glass is brought to the shape and size of the final ware and retained until able to stand without support.

The blank mold assembly has two functions, one to fabricate the finish and the other to provide the preliminary form or parison.

The first function, as presently practiced, is to shape, when in the inverted position, the so-called "finish". Following the formation of this finish, completed in one operation, the parison is shaped. In other words, the finish constitutes a completed index from which, as a start, all subsequent manipulations are performed. The viscous gob of glass falls by the force of gravity into the inverted blank mold to form a solid mass which is drawn by vacuum, or blown by compressed air, into the intricate recesses of the finish cavity. At the center and protruding into the finish cavity is the plunger, which, when it has been withdrawn, makes a starting cavity for the bubble which subsequently inflates the blank.

The second function of the blank mold assembly is to pre-form the glass in accordance with the practice which is briefly described as follows: The volume of the cavity of the blank mold is made in a predetermined ratio to the volume of the solid mass of glass and this ratio varies with the different types of ware, the various size openings in the finishes, and the proportion of height to diameter of the ware. These ratios lie between certain limits but ultimately serve their purpose, in each case, purely as a matter of the judgment and experience of the mold designer. When compressed air is introduced into the cavity provided by the plunger the glass is blown back and the original mass is inflated until the blank cavity is filled. Thus the ratio of the cavity to the solid mass of glass determines, to some extent, the size of the bubble in the glass and the general disposition of the glass around the bubble. This distribution of the glass is always planned on the presumption that it will be compensating, or to provide an overage of glass at certain portions of the parison so that the completed article will have an even distribution of glass, and, according to each special requirement, will make a strong glass wall. The blank also stretches during the time interval of the transfer and the bottom sags, the glass being mobile; and all of these movements are relative to the temperature of the glass, the temperature of the mold, and the duration of the operative time intervals which are involved.

Thus and in accordance with all of the above description, in view of so many variables and in such complex relation, the proposition of arriving at blank designs is practically impossible except by cut-and-try methods. Therefore, it is apparent that present methods for obtaining perfect quality ware are uncertain, contradictory and inadequate.

Now all of the above discusses the present practice of making a ratio between the blank cavity and the solid mass of glass on the presumption that, when the glass is blown back, the parison will have an even wall thickness and a comparatively uniform temperature. But this is not the case, and most difficulties which arise in connection with blank design are found to be caused by this incomplete and misconceived practice.

When the molten gob drops into the blank assembly at the feeding station certain operative elements move into place and it is blown down, then the table rotates one station and other elements move to place and the glass is blown back against the baffle. These various steps necessarily require time. Meanwhile the glass has been in contact with the iron and penetration has taken place according to the length of the time interval. If the time interval has been very short, then the penetration will be at a minimum, and, at blow-back, very little glass will be retained in the shoulder and an overage will be blown to the baffle. If the time interval approaches the longest permissible limit, then penetration will be pronounced, and, at blow-back, very little glass will be left to blow to the baffle. These two conditions deal with the

principle which is called "duration of penetration."

The weight of iron at the various parts of the mold operates in much the same manner according to the principle called "power of penetration". Thus, if the mold is made very light in weight at the shoulder then penetration will not be deep and an overage of glass will be blown to the baffle. If the mold is made too heavy at the shoulder (a very common error) then an excessive amount of penetration will take place and the bottom will blow light. Remember that all of this discussion refers to the action of the glass in the blank mold and to keep this explanation clear, the subsequent action in the blow mold will not be touched upon.

This primary penetration, or that which originates with the making of the finish, takes place up to the filling level of the molten glass in the mold. It is obvious, therefore, that when the upper or shoulder portion of the mold is running cold and a heavy shoulder has been made in the blank with a corresponding light bottom then there will be a break or highwater mark at the fill line. It is also obvious that if the weight of the glass in the shoulder is just right then the amount of glass blown to the baffle will be about right. This is practically correct for short molds but there is one other consideration which must be dealt with in connection with long jobs.

The third example deals with the principle of duration of penetration by means of the speed of the blow-back. Following the primary penetration, which extends to the highwater mark, the blow-back presses the inner area of the hot glass upward and outward in a manner to extend the wall of primary penetration and "string" the glass upward and in contact with the surface of the cavity. Investigation shows that penetration progresses with the upward movement of the glass as it touches the iron. If the blow-back is rapid this progressive penetration does not have to form a thick wall, therefore a decided highwater mark will show. On the other hand, if the speed of the blow-back is too slow then a thick "slug" is made near the filling level because too much time has been allotted to the expelling of the glass from the primary position.

Since, for mechanical reasons, the lowest obtainable time interval of the primary penetration is very often too long, because the machine cannot be adjusted to give a short enough primary penetration, and a practical compromise, in the nature of reducing the weight of iron of the blank around the primary position, is provided. To accomplish this a narrow slot is cored, in the casting for the mold, which extends around the cavity, to insulate a suitable section of iron from the main body of the mold.

Refer now to Fig. 1. The drawing illustrates a typical blank design for the Lynch Model 10 machine. This is chosen because the Model 10 machine works at a high speed and the time intervals, which are being discussed, are short. This tends to accentuate the phenomena and the necessity for a precise tuneup. At 1 is shown the filling level and at 2 is indicated the wall caused by the primary penetration, with 3 being the cored slot which will make the blank mold run hot at that section resulting in a low penetration. The proximity of the end of the cored slot to the filling level will vary according to the weight of the glass mold charge, the speed of the machine, etc. After the size and position of the cored slots have been determined by experience a final regulating of the primary penetration, a duty of the machine operator, can be obtained by a coordination of the timing of the blow-back to its speed. In passing, attention is directed to the fact that the means provided on present machines for these sensitive adjustments seem hardly adequate for the purpose.

In all of the above it has been clearly shown that distribution in the blank mold begins with the primary penetration and the time interval of the blow-down; that the wall thickness above the filling level depends largely on the speed of the blow-back; and that the highwater mark can be eliminated by proper use of these two factors. The most common fault in mold design is making the blank molds too heavy at the top and too light at the bottom. In order to obtain proper distribution of mold iron and for constructional reasons, cored slots should be used.

A careful consideration of the theory set forth reveals very complex operating conditions in the forming of glass. As has been pointed out, many factors are of critical importance; the temperature of the glass, speed of the machine, effectiveness and selectivity of the means for dissipating the heat of the molds, weight of the mold charge, size and weight of the finish, air pressure, and many others. Most essential of all is a better understanding of the way glass behaves in the mold by the operator of the machine. When it is realized that a Lynch 10 machine, operating at 40 per minute, has a time interval of only 1½ seconds between stations; and that the various mechanical elements have but a portion of this time to perform their duties, then it can be readily seen that the functions described in this paper are governed by split seconds. Since ductility is the only characteristic by which glass can be fabricated, and since penetration is the principle which controls it, it is quite plain that mold design and machine operation should be made to fit the penetration curve. Enough has been said to show the application of the penetration factor to the designing of blank molds and those familiar with operating practice should have no difficulty in grasping and utilizing the principles of ductility.

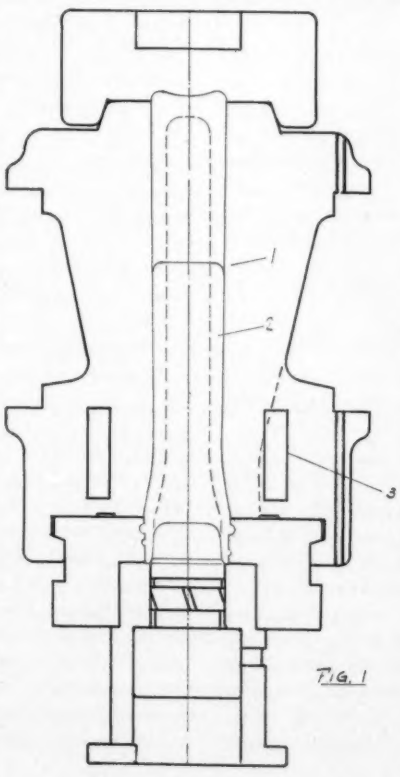


FIG. 1

● *The drawing at the left illustrates a typical blank design for a mold machine. The numerals point out the various parts.*

THE ART OF DECORATING GLASS

IV: MISCELLANEOUS DECORATING METHODS

By V. H. REMINGTON

B. F. Drakenfeld & Co.

The permanency of ceramic enamels has been responsible for their use in the past. The improvement of quality and application has done much to broaden their present use. The silk screen process and spraying methods have been described in some detail.[1] However, there are many other older methods worthy of consideration.

V. H. Remington

Rubber Stamp Methods

Prior to the application of silk screen decorating principles to ceramic ware, the rubber stamp method was frequently employed. Being a monocolor process, it provides an easy, simple method of applying any design which can be made into a rubber die or stamp.

The rubber stamp process has its limitations, chief of which is lack of color intensity of the fired print, due primarily, to the very thin layer of color applied. Nevertheless, it has been the means of decorating hundreds of thousands of hi-ball spoons, eye droppers, medicine glasses, beverage glasses, and many other articles.

Decorating by means of the rubber stamp process requires but little equipment. The following items are essentially all that are needed:

One plate glass square approximately 12″ x 12″
One composition or rubber roller 3″ to 4″ long
One wide blade spatula (6 inch)
Rubber stamp of design to be used
Small can of naphtha (for cleaning purposes)
Cotton for dusting
Pint of Heavy English Printing Oil
Necessary quantity of color

The operation is essentially as follows: A small quantity (½ teaspoonful) of printing oil is placed on the glass square and by means of the rubber roller, rolled out into a very thin film. The rubber stamp is then used to transfer a print of the oil to the ware after which, using a tuft of cotton, the selected color is both powdered and rubbed into the wet, tacky impression left by the stamp. If the oil seems to have piled up on the edges of the design, too much has been used. This condition can be corrected by working the oil film out still thinner.

For printing round objects such as rods, tubing or table glasses, it is often more convenient to mount the rubber die or stamp, design upwards, between two narrow wooden tracks which are about four inches apart. In this case the roller is used to coat the rubber die after which the object to be decorated is rolled over it.

To be able to transfer successfully a paste mixture of color and oil to a glass surface, as one would ink to paper, has been a dream of every decorator. However, inks are usually soluble dyes quickly absorbed by the paper with which they are brought into contact. Unfortunately, vitrifiable decorating colors are made of insoluble mineral pigments and coupled with the fact that, for all practical purposes, a glass surface may be said to be totally unabsorptive, a very poor impression always results if one attempts to apply directly a paste color by means of the rubber stamp. For this reason the slower dusting process previously described is used instead.

Ice Decorations

A decorative effect, somewhat unusual in appearance, can be secured with glass "ices." Ice is a colored or colorless, low melting, granular glass that has been crushed and screened to approximately 50-150 mesh size. A good quality ice should contain a minimum of dust.

Ware to be decorated is stamped with printing oil, in the manner previously described for dusting colors, or banded with a mixture of balsam of copaiba and turpentine. The ice is then poured over the wet impression whereby a layer of it will adhere evenly. Most ices mature in the neighborhood of 1050-1080°F. If underfired, the surface will be sharp and rough, whereas if overfired, the desirable surface texture is lost entirely.

Banding, Lining, Painting, Etc.

Banding, painting, and striping of glass with vitrifiable colors may be listed among the oldest of the decorating arts. Until the advent of machine lining a few years ago, they were all strictly hand operations calling for skill and patience on the part of the decorator. Fifteen to twenty years ago, hardly a home was complete without its hand painted lamp shades, many of which were works of art. Today, having entered an era of speed and production efficiency, there seems to be little time for elaborate decorations except those which lend themselves to mass machine production.

Banding Color Mixtures—Color used for banding seldom differs in physical properties from that used in other decorating operations. Chief prerequisites are that it must be finely ground and thoroughly dry.

The ability to mix color well for lining and banding comes only through experience. To those entirely unfamiliar with color handling and unable to secure the help of an experienced decorator, the following procedure is suggested:

Place a small amount of color on a glass tile, preferably one that has been lightly sandblasted. Add turpentine from time to time and work into a moderately stiff paste. At this point a few drops of fat oil of turpentine should be added. At first the color paste may be observed to set up, but as soon as enough fat oil has been added

[1] The Glass Industry, May, June, July, 1937.

the mixture should suddenly smooth out and become quite fluid. When the proper turpentine-fat oil-color balance has been secured, it is then only necessary to add more turpentine from time to time to replenish that which has evaporated.

Some decorators use oil of copaiba in place of fat oil of turpentine, but if so, great care must be exercised that too much is not added.

Another method of preparing color for banding is to make a very heavy paste of color and fat oil only and allow it to stand overnight. No more fat oil should be added than that which is absolutely necessary to wet the color. When ready to use, it should be comparable to very stiff putty in consistency. A small amount is cut out and placed on a glass tile and thinned down to best working consistency with turpentine.

Machine Banding—Machines have been developed for rapidly banding tumblers with bands of ⅛ inch width or narrower. The color is usually applied to the horizontally revolving tumbler by means of tracking wheels or discs. The color used on these machines is mixed with water and alcohol, or water and glycerine; the latter vehicle usually yields the best results. A vehicle often used consists of 1 part glycerine and 9 parts water. Sufficient color is added to form a thin, creamy mixture. Bands applied by machine methods stand out in greater relief than those brushed on by hand.

Striping—The operation of applying vertical or oblique lines to ware as a decoration is known as striping. This type of work requires a steady, well guided hand.

Filling In—Frequently the general outline of a subject is printed on the ware from a steel plate. Later various colors are painted over certain open portions of the design. This is known as "filling in."

The Steel Plate Transfer

For many years past both china and glass have been decorated by transferring the design in ceramic color from an etched or engraved plate. This is not a fast method and for that reason is being partially displaced by the silk screen method in many factories. In potteries especially, continuous rotary type printing machines are often used. On these, a revolving copper cylinder continuously prints upon tissue fed from a roll of the same material.

Etching the Plate—Although a great deal could be written concerning the etching of steel and copper plates for printing purposes, the subject will be treated here in the simplest phases only. Plate etching is a type of work calling for experience and skill by the workman.

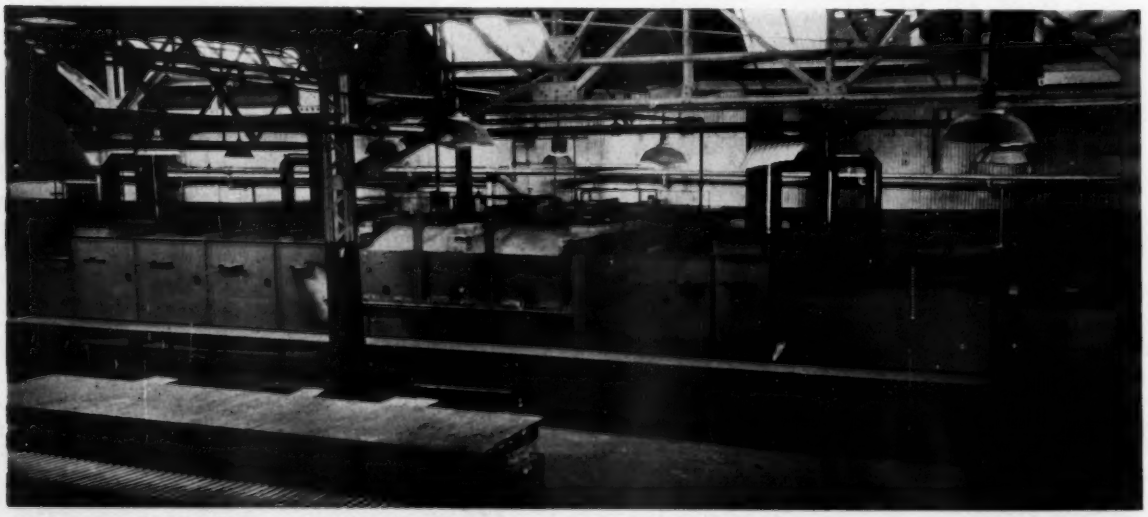
The steel plate is used more often than copper and should be made of good quality, even texture metal especially adapted to acid engraving. The plate is first coated with a thin layer of liquid asphaltum varnish. The varnish should be rendered somewhat plastic by dissolving one-quarter pound of beeswax in one gallon of varnish. This is done by heating the mixture in a double boiler for several hours.

When the varnish coating has hardened enough to make handling possible, the asphaltum is removed from the design portions, exposing the steel plate below. The plate is now placed on a level table and a dam of putty about ¾ of an inch high built up around the edges and dilute nitric acid (8 parts water, 1 part concentrated nitric acid) poured in. The progress of the etching is watched by occasionally testing or "feeling" with a sharp needle or pointer. The depth of the etch depends entirely upon the nature of the design and type of color to be printed.

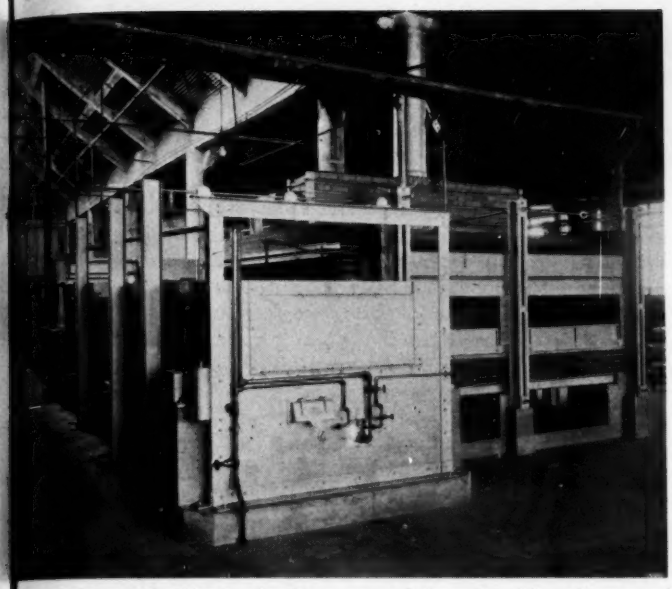
It is common practice in many shops to send the plate and design to a reliable photo-engraving company for etching, rather than attempt the work themselves.

Mixing the Color—The color to be printed is intimately mixed with a heavy printing oil or varnish and for best results should be run through a paint mill. A very stiff paste is made, too stiff in fact to permit working without first being warmed. Usually this is done by placing the printing color on a polished, cast-iron plate warmed from below by a small gas flame.

Inking the Plate—The printing plate is also warmed and while in this state is inked with the color by spreading the same over the entire surface. This done, the excess color is removed with a printer's plate scraper, a very thin but broad blade of flexible steel. The scraper is drawn evenly over the entire surface, the operation being repeated until barely any color is visible.



● *Continuous belt, muffle type combustion, decorating lehr. Courtesy of Frazier-Simplex, Inc.*



● *Combination bending oven and decorating lehr. Courtesy of The Amsler-Morton Company.*

The Printing Paper—The transfer paper for receiving the impression from the engraved plate is a special thin stock possessing considerable strength. Before use it must be coated with soap on the side to be printed so that the color does not come into direct contact with the paper, but rests on the layer of soap.

The soap for this purpose is prepared by dissolving in boiling water enough pure English soft soap to form a rather viscid, translucent liquid when warm. The coating is best done by means of a broad soft brush.

Printing—After the plate has been inked, it is laid on the bed of a decorator's printing press and covered with the damp printing tissue, coated side down. A heavy felt blanket is then placed over the paper. The upper roller of the press must also be faced with felt in order to distribute the pressure evenly. The plate is run forward, then backward through the press and taken out.

The impression having been made, the paper must be dried before it can be removed. This may be accomplished by heating over a gas jet, steam coils, or blowing with air. Usually a combination of heat and air are used. When perfectly dry the paper is carefully lifted from the plate. It is turned printed side up and all the unprinted portions cut away.

Transferring the Design—The printed side of the paper is applied to the article being decorated and pressed down smoothly with the hand. Next the paper is vigorously rubbed with a printer's rubbing brush so as to bring every portion of the print into absolute contact with the glass. This done, the ware is next immersed in lukewarm water until the paper peels off. Contact with the warm water causes the paper to swell up rapidly and as the soap dissolves, connection between soap and color is destroyed.

Firing the Ware—Ware decorated as above described is generally fired in the usual manner. Owing to the heavy oil used in the print, the firing cycle should not be too short. Sufficient time should be allowed to burn out all oil before the ware enters the firing zone.

Steel Plate Transfer—Without Press—If the design is small, or long and narrow, it may be printed and transferred without the use of a press. The etched plate is inked and cleaned in the usual manner, likewise the printing tissue is sized with soap.

To make the print, a strip of paper is laid over the design and rubbed into intimate contact by means of a stiff bristled brush. This done, the paper is pulled away and transferred to the ware.

Other Uses of Etched Steel Plate—It is possible, by regulating the depth of the etched design in the plate, to transfer acid resist, sandblast resist, and even straight varnish. If varnish only is transferred, color powder or ice may be dusted into it.

Luster Decorations

Beautiful iridescent effects can be produced on glass by means of colorless and colored lusters. The colorless lusters give the glass a peculiar mother-of-pearl effect, whereas the colored lusters impart an iridescent, as well as a colored metallic sheen to the glass surface.

Generally speaking, lusters are metallic resinates dissolved in a suitable solvent such as lavender oil.

Application—Luster colors can be applied by spraying or brushing. They may be used straight or diluted with oils and essences supplied by the manufacturer for that purpose. Lusters and thinning agents must be kept absolutely free from water, for the presence of even the slightest trace of moisture in a luster is likely to cause the formation of small white spots. The pieces intended for decoration must be absolutely clean and dry and should have acquired room temperature before work is done upon them.

Firing—The decorated ware should be allowed to dry completely in a dust-free place before firing. The temperature should be increased as gradually as possible to prevent blistering or scaling. Ventilation ports on the lehr should be opened to prevent ready escape of the evaporating oils.

Most lusters mature satisfactorily if fired from 1050° to 1080° F. Thin lead glass can be fired at slightly lower temperatures.

Metallic Decorations

In addition to vitrifiable colors and lusters, glass may be decorated with gold, silver and platinum, thus imparting a greater richness of appearance than is possible by any other means. Only metals can be used which can be heated to relatively high temperatures without oxidizing.

The metallic decoration may be applied to the glass in the form of paste consisting of oil, flux, and the metal in very finely divided form. After firing, the metal remains matt and devoid of luster until burnished. On the other hand, if special solutions of the metals are used, the luster appears at once after firing and no burnishing or polishing is necessary.

Burnished Gold—Burnished gold is frequently used for decorating glass. It is supplied by the manufacturers in paste form and is usually applied by brushing, though a specially prepared product can be printed from a steel plate. After the gold has been fired, it is polished with wet "burnishing" sand which is a fine, round grained sand that does not scratch.

Burnished gold ranges in price from $5.50 to $31.00 per troy ounce, depending upon the degree to which the gold paste has been diluted with cheaper metals, such as mercury and bismuth.

Burnished Silver—Burnished silver can be applied, fired and burnished in much the same way as burnished gold. However, the beauty of silver decorations is less permanent since the metal tarnishes so easily.

Bright Gold—Liquid bright gold is essentially a gold resinate dissolved in turpentine and lavender oil. It also contains a small amount of rhodium which causes the gold to turn bright, without burnishing, when fired. Bright gold is sold in bottles holding 100 grams of the solution. One bottle of average cost gold will usually provide sufficient material to band 300 dozen tumblers with ⅛ inch bands.

Solutions of liquid bright gold, bright silver, or bright platinum, all have about the same consistency and handling qualities. They are applied with a brush in the same manner as vitrifiable enamel except that the coating is much lighter. Applied heavily, the metal decoration will not adhere to the glass as well as a medium weight application.

Decorating Glass by Electroplating—Very fine decorative effects can be produced by electroplating the glass with one of the noble metals. Silver is used to a very large extent and the plating of the metal is usually referred to as "silver deposit" work.

As a rule the design is first printed and fired on the glass with a paste mixture of precipitated silver, flux and oil. The ware is then immersed in an electroplating bath, all isolated portions of the decoration connected with the current source, and a deposit of pure silver plated over the fired design. Upon removal from the bath the deposit is polished.

To prevent the silver from tarnishing, it is frequently given a light plating of rhodium.

The Decalcomania Transfer

The decorating of many types of ceramic ware with lithographed designs of several colors has been made possible by means of the decalcomania transfer (decal). It has been used chiefly by the potteries making dinner ware and, to a certain extent, by the manufacturers of porcelain enamel ware. However, the use of ceramic decals by the glass decorators has been limited. The principle reason for this being that the transfer of color is quite thin, full of varnish and difficult to fire glossy at ordinary glass decorating temperatures. Best results are secured if the transfer is made to opal glass which offers a good, strengthening background for the print.

Printing—Ceramic decals are printed by lithographic methods, the principles of which were discovered by a Bavarian, Alois Senefelder, at Munich, in 1796. He found near there a porous calcareous stone that would absorb both grease and water.

In stone lithographing, a grease composition impression of the lines and areas of a single color are made on fine grained limestone. The stone is treated with dilute nitric acid for a brief period, which attacks the uncovered portions, leaving the greased portion slightly raised. The stone is placed in a back-and-forth press, and touched at one end by a water-wet roller, further on by a varnish-wet roller; the bare stone is moistened while only the greased portion takes the varnish. Decalcomania paper is then printed with the varnish, after which ceramic color is dusted and powdered into it. After the first color has dried the second, and subsequent colors are printed from other stones. The entire design is given a final coat of varnish to prevent the printed colors from dusting off, and aid in effecting a good transfer contact with the ware to be decorated.

Most ceramic decalcomanias are printed on duplex decalcomania paper. The duplex paper has a heavy backing sheet to which is adhered a removable tissue. The tissue is coated with albumen and water soluble gums.

Transferring—In making the transfer, the ware is first coated with a thin layer of decalcomania varnish. To minimize blistering it is usually better to use a mixture of 3 parts turpentine and 2 parts pure decalcomania varnish. Next separate the heavy packing paper from the tissue and lay it, color side down, on the ware as soon as the varnish has become tacky. Smooth out the tissue and rub into intimate contact with the glass. This done, immerse the article in lukewarm water until the paper becomes separated from the color print and floats away.

Firing—The successful firing of decalcomania prints requires a long, gradual, preheating treatment. If fired rapidly, blistering and reduction of the color is certain to result.

Firing the Ware

To complete the decorating cycle, the ware with its applied color must be fired under carefully controlled heat conditions. In earlier times this was accomplished by means of muffle kilns. These later gave way to hand-drawn pan lehrs, forerunners of our present day, automatically controlled, continuous belt lehrs.

Decorating lehrs vary from 25 to 125 feet in length, and from 2 to 8 feet in width. Average length, however, is between 75 and 100 feet and for uniform firing conditions a width in excess of 4 feet is not often recommended.

The firing and preheating zone represents the heart of a decorating lehr. Production speed and the ability to fire refractory enamels well are dependent upon its construction. The heat may originate either from the sides through suitable side wall muffle construction or from combustion chambers placed either above or below the belt. Study of all types indicates a combination of both top and bottom heat to give best all-around results. In the case of hard (refractory) colors the top heat can be carried 75° to 100° higher than the bottom heat and still fuse the colors satisfactorily without chain-marking the ware. (Chain marks are blemishes or dents on the glass left by the lehr belt at point of contact with the softened glass.)

The approach to the main chamber may be termed the preheating zone. It is here that all volatile oils and organic carriers must be removed from the applied color. For that reason, one should aim to bring about a balance between the maximum temperature of the zone and duration of the preheating time.

There is some disagreement as to what constitutes the correct preheating curve. It is contended by some that there should be a gradual and uniform rise in the temperature between the front of the lehr and firing zone. From an annealing standpoint this may be theoretically correct, but for the purpose of dissipating oils the efficiency of the front end is materially reduced. For firing sprayed, banded, and silk screen printed ware, it is our contention that just inside the lehr entrance the tempera-

ture should rise rather abruptly so that the ware passes through at least one-half of the preheating zone exposed to temperature ranging from 700°F. to 850°F. At these temperatures volatilization of the oils is rapid and quite complete. However, ware decorated with decals, lusters, and metallic decorations should be heated as gradually as possible.

The decorating lehr may be heated with gas, oil or electricity. The latter is easily controlled, but gas, more often being the cheapest source of fuel, is probably employed in at least 95 per cent of the decorating lehrs.

Proper ventilation is another factor in lehr construction that too often has been left to chance. White enamels and delicate shades of pink must be fired in an oxidizing atmosphere. Decomposing oils or waste fuel gasses are strongly reducing and should be quickly removed from the firing zone. Liquid bright silver, platinum, and bright gold are especially sensitive. Fired under poor conditions, the metal deposit will not only be dull but offer no resistance to the slightest abrasive action.

Days of high humidity are also likely to affect the finish of fired ware. This applies especially to the soft colors which have been printed with oil. Unless removed by increasing the firing zone ventilation, the volatilized and partially decomposed fumes attack the enamel with deleterious results; usually producing a very dull or matt finish. Decorations, such as screen prints, that have been applied with an oil vehicle will usually blister if run through a new lehr from which the moisture has not been entirely removed. The atmosphere of high humidity seems to retard the evaporation of the oils.

It is best to fire the ware as soon as the decoration has been applied. Some oils oxidize on standing and become difficult to remove later in the firing operation.

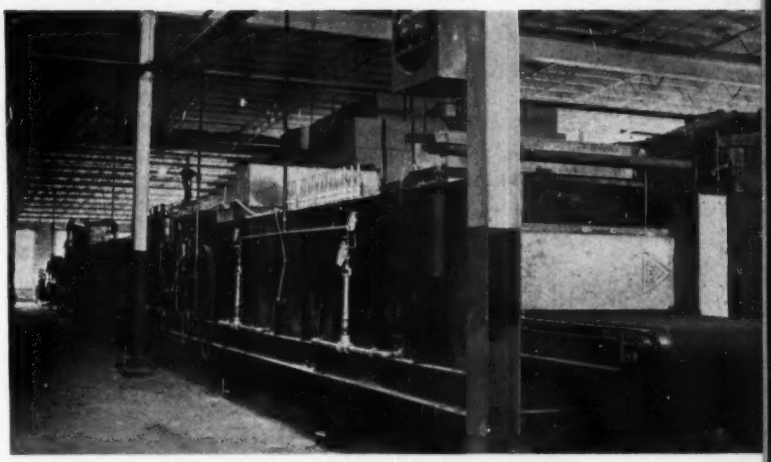
Many times the location of a lehr has a great deal to do with its operation, particularly as regards draughts. In some instances if the lehr parallels the direction of the prevailing winds, the heat is driven either forward or backward as the case may be. Curtains at the ends of the lehr can be lowered, of course, to minimize the effect, but with tall ware or a partially loaded belt a rather difficult problem is presented.

Frequently the lehr is built so as to connect two buildings or two large rooms of the same building. Owing to differences in temperature or natural draughts between the separate units, it is often hard to maintain uniform heat within the firing zone. Accordingly, some thought concerning this possible source of trouble, before a lehr has been located, may save no little worry later on.

The early decorating lehrs, like the early annealing lehrs, used pans to convey ware from one end to the other. Most modern units make use of an endless, heat resisting wire belt. The open mesh construction of these belts aids in heat transmission and air circulation.

By means of pyrometers and accessory equipment it should be possible to maintain a constant check on firing conditions. Owing to the fact that the thermocouples must be located a safe distance above and below the plane of ware travel, a pyrometer does not often indicate the actual temperature of the ware; nevertheless, it enables one to maintain correct heat levels throughout the lehr.

The firing of decorated ware is, within certain limits, a function of time and temperature. In other words, a fast belt conveyor speed at a given temperature often produces the same results as a slower belt at lower temperatures. The weight and thickness of the glass, and the type of vehicle used in applying the color are determining factors. Some oils require a slow preheating treatment. On the other hand, heavy ware must be heated and cooled slowly for reasons of annealing. Light, thin blown tumblers can be run through a good lehr in 30 minutes, while heavy glass, such as milk bottles, may require as much as three hours' time.



● *Combination muffle and open firebox combustion decorating lehr. Courtesy of Hartford-Empire Company.*

Testing Methods

During the past few years there has been a growing demand for acid and alkali resistant colors in the milk bottle, beverage and other fields. In order to be able to check the degree of resistance to cleaning and pickling solutions the following tests have been developed.

Alkali Resistance Test—The bottle to be tested is subjected to 5 twenty-minute immersions in a 5 per cent sodium hydroxide solution, the temperature of which is held at 180°F. At the end of each immersion the bottle is removed for observation by rinsing with clean water and wiping dry with a clean towel.

A 5 per cent sodium hydroxide solution is made by dissolving five ounces of sodium hydroxide in ninety-five ounces (by weight) of water. Water lost from the testing bath by evaporation should be replaced from time to time to maintain the original concentration.

Acid Resistance Test—Prepare a 5 per cent solution of acetic acid by adding one ounce of glacial acetic acid to nineteen ounces of distilled water. Immerse a portion of the printed bottle in this solution, the temperature of which is kept at 75°F. Examination of the samples should be made at the end of each hour. A good acid resistant color should be little affected after five hours immersion in the acid.

Sulphide Resistance Test—The resistance of glass enamels to sulphide fumes may be determined by immersing the fired sample in a solution of hydrogen sulphide. The solution may be prepared by passing hydrogen sulphide gas into water at room temperature. The reaction is rapid and less than one minute's immersion of the sample in the solution is required to determine its degree of resistance. Ordinary soft enamels will become black or deep brown in color, whereas a good resistant enamel will barely discolor.

A LABOR SURVEY OF THE CONTAINER INDUSTRY

During the past few weeks the member companies of Glass Container Association of America have had an opportunity to compare the wage rates, hours worked, etc., in their own plants with similar information from the plants of other members of the Association. This information is included in a very extensive and detailed Labor Survey, the data for which were secured by the G. C. A. from all member plants located east of the Rocky Mountains. A similar survey in Pacific Coast container plants is now in progress.

The survey covers 39 companies, said to represent 99 per cent of the total automatic machine production east of the Rocky Mountains, and includes data from 61 plants. All of the information was gathered by personal visit to the individual plants, thus making it possible to correlate the rate data according to the exact duties performed. The field work was started March 1, 1937, and completed May 1, complete data for the forepart of 1936, as well as 1937, being gathered.

One of the interesting features of this survey is the standard job classification, developed from a study of several companies made prior to the survey. Necessarily the classification of jobs has been made more detailed than would apply to the average plant, in order to recognize the greater range of responsibility existing in the larger plants and, at the same time, to make sure that the rates in a particular classification would cover comparable duties in all plants.

The standard classification segregates the plant personnel into some seventeen departments, each of which is then divided into job classifications covering all types of work performed in that department, from manager or foreman down. Table Number I shows the standard departments, together with the number of job classifications and the total number of employees in each department.

While wage rates on individual jobs are found to vary considerably among different plants and in different sections of the country, it is of general interest to note that wage rates have increased in the job classifications covering 99.38 per cent of the total number of employees. Wage rate increases from 1936 to 1937 in four of the larger job classifications, representing nearly one-third of the total number of employees in the 61 plants, are shown below.

TABLE I

Department	*Number of job Classifications*	*Number of Employees (61 plants)*
Batch House	5	816
Furnace Department	4	488
Flowing and Forming	14	4,908
Annealing	2	195
Selecting and Packing	16	6,505
Carton Stock Room	5	234
Carton Assembly	9	1,290
Warehouse and Shipping	6	2,134
Boiler and Producer Plant	5	338
Compressor (Power) Plant	3	218
Electrical Department	3	220
Maintenance & Machine Repair Shop	21	1,148
Mould Maintenance & Repair Shop	10	1,134
Mould Shop & Office	13	994
General Plant	17	2,099
Plant Office	10	818
Office	2	368
Totals	145	23,907

TABLE II

Job Classification	*Total Number of Employees*	*% Rate Increase*
Flowing & Forming Operators	2,210	10.5
Male Selectors & Packers	1,859	11.8
Female Selectors & Packers	2,752	18.4
General Plant Labor	1,003	14.1

Perhaps the best indication of the general status of the industry, as regards wage rates, hours worked and total wages paid, is found in a general breakdown of the personnel into various classes of labor, as shown in the table below, Number III.

It is apparent from the survey data that the wages paid the various classes of labor compare more than favorably with other branches of industry. Total employment in this industry has increased a little over 11 per cent during the past year, but the total amount disbursed by these 61 plants in wages and salaries has increased by about 25 per cent in the same period.

TABLE III

	Total Number of Employees		Average Hours per Week		Average Weekly Wage		Total Wages per Week	
	1936	*1937*	*1936*	*1937*	*1936*	*1937*	*1936*	*1937*
Male Employees —								
Skilled Labor	6,149	6,698	41.4	41.8	$34.09	$37.73	$209,643	$252,690
Semi-skilled Labor	6,039	6,544	41.0	41.7	21.14	24.25	127,682	158,723
Common Labor	5,036	5,397	40.9	41.3	17.96	20.80	90,423	112,264
Female Employees —								
Semi-skilled Labor	2,898	3,445	39.2	39.4	15.77	18.24	45,700	62,839
Common Labor	687	750	40.9	39.4	14.57	16.67	10,008	12,499
Industry Total —								
All Classes (Including Apprentices)	21,582	23,907	40.8	41.2	$23.11	$26.08	$498,864	$623,469

"SECURIT" PLATE GLASS

• *In the manufacture of tempered glass, and its use in Europe, there is much that is interesting and not generally known to American glass men. We are indebted to the publishers of "Glaces et Verres" for permission to translate from an article appearing in the January-February number of that Journal. Signed with the initials "R. L.," this article is entitled "La Glace Securit. Ses Qualités Physiques. Ses Characteristiques," and has been translated for* THE GLASS INDUSTRY *by A. H. Schottland. Regretfully and in order to eliminate material already familiar to our readers we have had to replace the introduction in the French original by the first five paragraphs, the translator's own writing.—The Editor.*

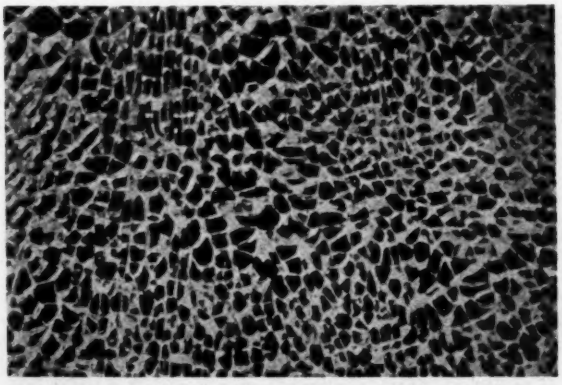
Means for tempering Plate Glass on a commercial basis were first perfected abroad. Developed with the technical collaboration of the St. Gobain Company, the first patent in France was secured by the Boussois Plate Glass Works, the Compagnies Réunies des Glaces et Verres Spéciaux du Nord de la France, on May 1, 1928.

Marketed under the trade-name Securit, tempered Plate Glass has found wide employment in France. Beside replacing ordinary glass in the automotive field, it has made a place for itself in railway cars, steamships and aeroplanes.

Tempered glass retains all the qualities of ordinary glass and possesses certain virtues of its own. It will withstand considerable elastic deformation; it will carry considerable weight in a flat position while being itself supported at its extremities only. It will sustain shock to the extent that it can be repeatedly struck by a hard object, or flung at a hard body, without breaking.

Its manner of shattering is unique in glass. It breaks finally into small, facetted crystals which often remain clustered or interlocked with one another, although their outlines are perfectly visible (Fig. 1). The virtue of this method of fragmentation is that the clusters lack the cutting edges characteristic of untempered glasses. Once broken, the glass acts as if it were friable, and it may be handled freely—even held tightly and crushed in the fist—without the skin being abraded.

As is evident from the process which it undergoes tempered glass must be cut or shaped (when necessary) before being reheated. As will be later evident, none of its surfaces or edges can be impaired without the entire plate being, in consequence, completely broken.



• *Fig.* 1. *Securit glass after being shattered, showing the crystals still maintaining their original position.*

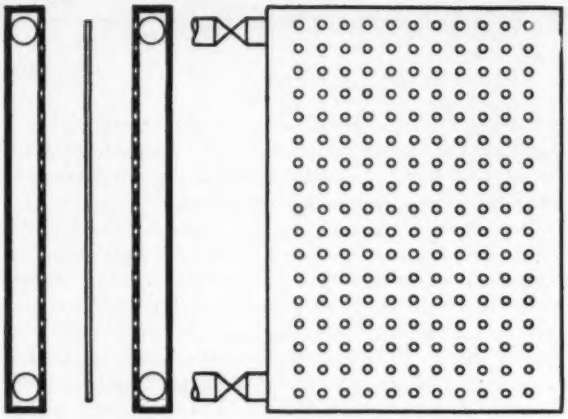
Method of Manufacture: To produce Securit plate glass, ordinary polished plate glass undergoes a special tempering treatment which consists in rapidly chilling the glass which has already been brought to a temperature very close to its softening point. Under these conditions the outer layers solidify immediately while the inner layers remain plastic for a certain length of time because of the poor thermal conductivity of the glass. The inner layers, reaching their solid state after the outer layers, compress the latter and force themselves into a condition of tension.

It goes without saying that this sudden chilling is not effected in any haphazard fashion. The chill must be properly administered, properly directed, so that the resulting internal stresses (compression and tension) may be judiciously distributed.

Into a furnace, built of refractory blocks and generally heated by electricity, the two long faces of which are very close to one another, a plate of glass is suspended between tongs. After having been reheated to a point barely above softening temperature, the glass, which is always hanging, is placed between two metal plates which are perforated and connected to numerous inlet tubes at the perforations (Fig. 2). Through these perforations a cold fluid is admitted under pressure. This brings about an almost immediate chilling of both surfaces of the glass.

Explanation of the Phenomena of Internal Stress: Glass is a poor conductor of heat, but it is subject to expansion. When placed in a furnace to be brought up to its softening point, it remains there for a length of time sufficient to enable it to reach a uniform degree of heat throughout its mass. At this moment it is physically homogeneous. After having received the impact of a sudden current of air, its surface becomes chilled and taut, and constitutes a sort of surface crust in a state of contraction. However, the interior of the glass has remained within softening temperature and thus acquires a tendency to occupy a space larger than that which is permitted it by its outer crust. Even though they subsequently cool, the inner layers remain in this state of tension. These stresses may not, however, exceed the coffiecient of resistance of the glass under pain of inducing breakage; but it is known that if glass exhibits poor resistance under tension it has, on the other hand, a resistance to compression of 9,000 kg. per square cm., noticeably in excess of that of steel. The possession of these qualities brings about these structural modifications which result happily for Securit glass.

Let us recall the well known example of the glass drop: While this withstands violent shock, it will pulverize when its tail is broken. Then its internal stresses are relieved by the destruction of the equilibrium between those layers in a state of tension and those in compression. Since the same applies in the case of Securit plate glass, we perceive why it is impossible to drill a hole



● *Fig. 2. Sketch of glass tempering furnace.*

or to do any major work (seam, chamfer, bevel) on a plate of glass already treated. Any impairment of the surface penetrates through the exterior crust and relieves all stresses by destroying the equilibrium and breaking the plate.

During a lecture given at the Chemical Institute on January 10, 1935, Mr. Bernard Long, Director of the Central Laboratory of the Saint-Gobain glass factories, explained the physical phenomena encountered in Securit plate glass as follows: The distribution of stresses through the thickness AB on a plate of tempered glass can be represented by a curve such as in Fig. 3a.

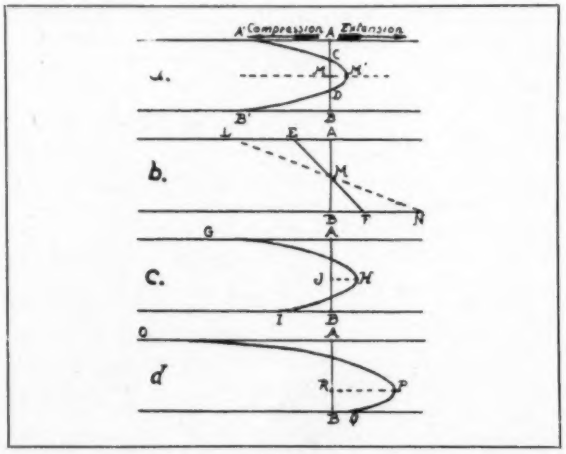


Fig. 3.

Compressive stress is read from right to left and tensile stress from left to right perpendicularly to AB. In absolute value, the maximum compressive stress, measured by AA^1 and BB^1, is much more important than the maximum tensile stress, that of the middle layer measured by MM^1. At C and D, which fall into two so-called neutral zones at equal distances from the faces, the stresses are nil.

If we place a load upon a plate of tempered glass which rests upon two supports, so as to superimpose upon the first condition of strain, a second represented by the straight line EF (Fig. 3b), the result is a redistribution of stresses represented by the curve GHI of Fig. 3c.

The compressive stress of the upper face increases and takes on the value $AG = A^1 + AE$. The compressive stress of the lower face is brought down to the value $BI = BB^1 - BF$. For a greater load, one that would in non-tempered glass bring about a condition of strain represented by the straight line LMN, shown by the broken line in Fig. 3b, the resulting curve would be OPQ (Fig. 3d).

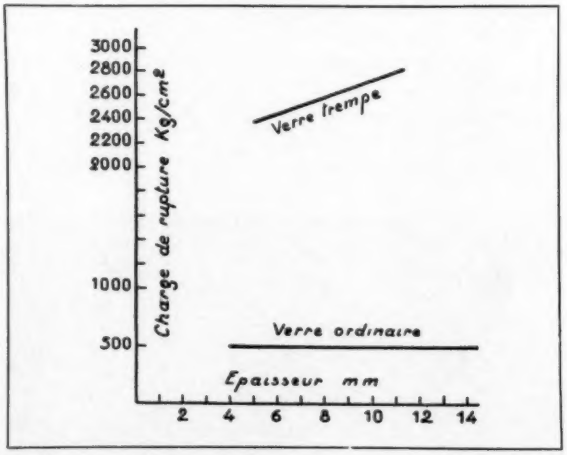
It is readily seen that, in order to bring about the fracture of a plate of tempered glass, the load has to be of magnitude sufficient not only to cancel the initial compressive stress of BB^1, but to carry the tensile stress BQ beyond the limit which the lower layers could withstand. It is evident that the breaking point of a plate of tempered glass is much higher than that of a plate of ordinary glass of like dimensions.

In the preceding paragraphs, our attention has been concentrated on what takes place in the lower face. We must not, however, overlook that the fact of loading the plate of tempered glass has carried the maximum tensile stress from the value MM^1 to the value JH, then to the value RP.

In general it is not possible to induce fracture of a sheet of tempered glass except by means of an extra heavy load for, as we have indicated previously, the glass in the inner layers may be considered as having approximately twice the resistance of that of the surface. However, if the maximum tensile stress at the outset, MM^1, were too strong (in the event of over-tempering), the glass at the inner layers could be "superextended" and could explode under a light load, or at least one noticeably less than the breaking load of the same plate of glass not tempered.

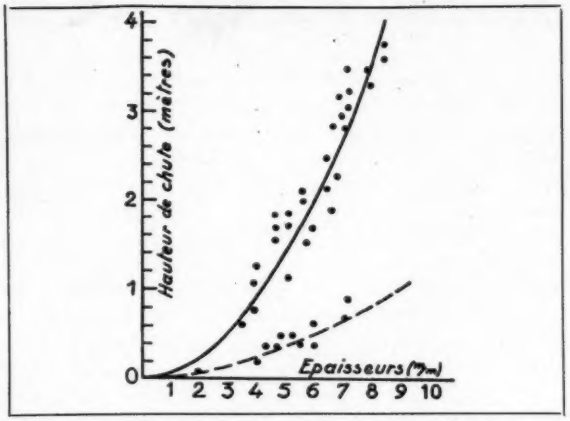
From the preceding considerations, it follows that there exists with regard to tempering, an optimum treatment producing a state of optimum strain so that upon loading, the limit resistance of the interior and of the surface may be reached simultaneously.

We, therefore, understand that the thermal treatment to which Securit plate glass is subjected calls for minute



● *Fig. 4. Resistance to Flexing.*

care in manipulation and a degree of control in which success depends upon automatic operation. Only specialized factories having suitable equipment are capable of manufacturing a product to give complete satisfaction. In addition, it is only these specialized factories that con-



● *Fig. 5. Experiments with a metal ball dropped on Securit plate glass (heavy line) and on ordinary plate glass (broken line) on test samples 30 centimeters square.*

centrate on controlled processes and on experimental checks that maintain the stability of the product.

Resistance to Deflection: The tempering of plate glass increases its resistance to deflection from five to eight times, depending on the thickness of the sheet. The values of this resistance are subject to slight variations.

The elasticity of plate glass remains unchanged by tempering. The modulus of elasticity is 750,000 kg. per cm. as for ordinary plate glass. Securit plate glass likewise follows the laws of the linear relation of distortion to the load up to the point of fracture.

Resistance to Shock: Resistance to shock, measured by the height of the fall of a ball of steel weighing 950 gr. which causes breaking, is, on the average, five times higher for a plate of Securit glass than for a plate of ordinary glass.

Thus in an experiment made upon the rear lights of an automobile (57 x 255 cm., and from 5.1 to 6.5 mm. thick), we find it necessary to allow the ball to drop from a height of about two metres, while in the case of plates of glass not tempered, a fall of 30 cm. is sufficient to break them.

Resistance to Crushing Loads: A windshield of Securit glass placed with its greatest dimension in the vertical position usually withstands a force up to 400 or 500 kgs. A small square plate, 20 cm. x 20 cm., can withstand up to 6,000 kgs.

Resistance to Torsion: This experiment was made with a windshield and with small sheets mounted in the four different ways indicated by the sketch in Fig. 6.

The displacement was measured with the aid of record-

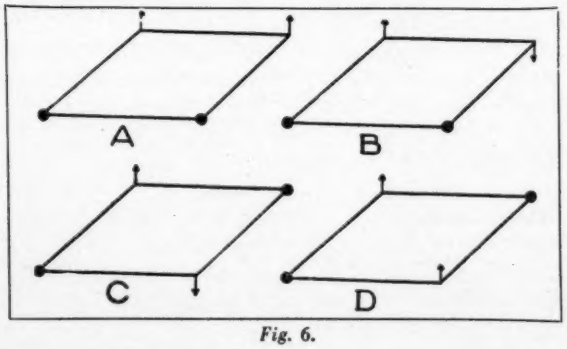


Fig. 6.

EXPERIMENT A		EXPERIMENT B	
Load	*Displacement*	*Load*	*Displacement*
kg.	*mm.*	*kg.*	*mm.*
20	6.0	20	8.8
40	13.0	40	17.2
45	14.6	50	21.2
50	16.2	60	25.4
55	18.0	70	29.2
Fracture		80	33.0
		90	36.6
		95	38.8
		100	40.4
		102	41.2
		Fracture	

Note: The distance between the plane of the support and the point to which force was applied is 25 cm.

EXPERIMENT C		EXPERIMENT D	
Load	*Displacement*	*Load*	*Displacement*
kg.	*mm.*	*kg.*	*mm.*
5	2.2	20	4.6
7	3.3	30	6.8
10	5.2	40	8.8
12	6.4	45	9.8
15	8.3	50	10.8
17	9.8	55	11.6
20	11.8	60	12.4
40	18.6	65	13.0
45	20.6	67	13.6
50	22.6	Fracture	
55	24.4		
Fracture			

Note: The distance between the two points of support is 1 metre.

ing devices and the experiment was carried through to the point where the glass broke. The results, for the windshield, are shown in the table above.

Resistance to Vibration or to Repeated Shock: Test plates of glass measuring 20 x20 cm. and two windshields measuring 104.8 x 33.3 cm. were placed in a wooden box and subjected to 800 vibrations per minute. They have undergone 400,000 repeated shocks without the slightest change having taken place.

Resistance to Thermal Shock: First experiment: The sheet of glass is placed in water at 80° C., then in water at 15° C.

Normal plate glass breaks.

Securit plate glass sustains the same operation five times; then it is placed in boiling water for ten minutes and subsequently plunged into cold water at 15° C. for another ten minutes. On the same plate a molten lead alloy (melting point 230° C.) is flowed and this is followed by sprinkling over it water at 15° C. No breakage.

Second experiment: On a sheet of Securit plate glass a molten lead alloy is flowed under the same conditions as shown above. Immediately with an oxyacetylene torch the lead alloy is remelted upon the glass itself. The light is then sprinkled with water at 15° C. without any breakage being noted.

To conclude, we may add that neither the disappearance of its properties of resistance, nor a change in its manner of fragmentation are to be feared for it with the passage of time. Neither as it ages, nor as Securit plate glass performs its work under heavy loads or continued deflection, does this product, known and in use for the past eight years, undergo any modification of its characteristics. Practical applications completely confirm the control effected by photo-elastic measurements in the laboratory before and after the different experiments above.

TEMPERATURE CHANGES IN MELTING PILES OF BATCH

Glashütte for May 18, 1937, publishes some interesting experimental results obtained by Dr. Jebsen-Marwedel.

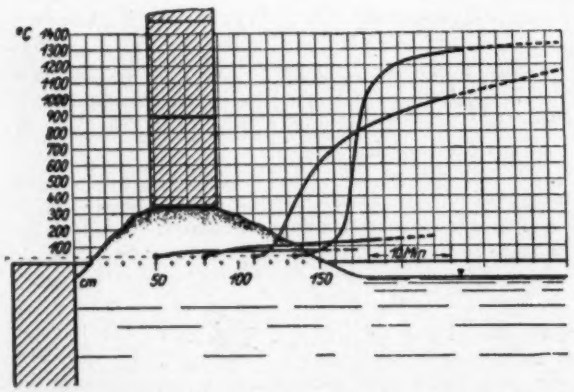
It is remarked that the temperatures in a glass tank have only the most general relationship to the actual temperatures within the material which is being melted. This is especially true when raw batch is considered. The crown pyrometer is practically worthless so far as the temperature of heat within the melting batch is concerned. It appeared worth while to get some sort of direct observations as to the temperature gradients in the batch and the time required for the heat penetration.

It became necessary to make direct temperature measurements. Trustworthy data on this point were completely lacking. A noble-metal thermocouple was designed of sufficient length so that it could be inserted into the interior of a freshly charged heap of batch in a melting tank of the dog-house type. The position of the themocouple was at about the height of the tank wall proper. The appended diagram sets forth some of the results.

The first reading at a 50 cm. "depth" gave, in the course of 30 minutes, indications of a feeble heating up to about 70°C. Even in a depth of 75 cm. ("depth" evidently meaning distance from the rear wall of the dog-house), showed in the same time only a temperature of little over 100°, although the batch pile was floating on glowing hot, molten glass as the usual moving island.

After these surprisingly low results, the highest temperature was determined at which the melting batch is eventually exposed. This was accomplished by thrusting the hot junction of the thermocouple just through the melted crust of the batch. Here were found without exception temperatures of only a little over 1300°, although, at the same time, the indication of a pyrometer placed in the crown of the melting tank stood at about 1420°C. The cooling influence of the batch upon its hot surroundings is therefore unrecognizable.

The attempt was now made to measure how long it took this hottest layer of the batch to reach these temperatures which were to be found only to a depth of about 100 mm. inward on the side of the batch pile toward the fire. After six minutes, the temperature climbed steeply, so that after 10 minutes it had reached 1000°C, and after 20 minutes, arrived at 1300°. Since it is recognized from experience with crucible meltings that in this time very small increments of batch melt with extreme slowness between 1100° and 1250°, it becomes quite clear that the important reactions for the complete melting temperature of the batch take place, in all probability, below 1300°, even at 1200°C. But at a depth of 30 cm. from the fire side inwards, the temperature gradient is so much less steep that after 6 minutes only 500° has been reached, after 10 minutes, 700°, and after 20 minutes, only 1000°C. However, when the batch pile has been pushed forward into the furnace in order to make room for another addition, the ascent of temperature may be a little steeper; but for the greater part of the batch, on account of its very poor heat conductivity, there can be no very great change in the temperature gradient. Similar consequences can very well be assumed in the process of melting in closed pots.



• *The measured course of temperature rise at various places within a heap of batch melted under commercial conditions.*

Therefore we make the observation that the essential reactions taking place in the time available are accomplished rather below 1200° than in the interval around 1400°, which might seem to be indicated by the usual crown pyrometer applied to the measurement of internal furnace temperatures. The latter serve much more truly only after the heating up of the molten glass which has really been melted down in a lower temperature range. Being hotter, it is now brought into the flame condition. To be sure, this heating up is probably still accompanied by limited residual reactions which are probably none the less important for the composition of the glass-melting process in its entirety.

Consequently, it is easy to see that observations on the melting temperature of a certain batch in a certain furnace cannot be arbitrarily carried over to apply to other melting conditions. Much depends upon whether the melting conditions — independent of details of construction of the installation — are certainly similar. In connection with the foregoing investigations, it is established that during the melting of commercial glass batches, there are reactions which go along with the temperature, but whose course cannot be strictly followed by following temperature readings. To this study belongs not only a knowledge of the atmosphere of the furnace, but also the manner of distribution of the batch and its intimate chemical complexity. It appears also to be established that much importance should be assigned to this inner complexity of the glass batch.

Through comparable measurements on a technical scale, the conclusion is reached that the reaction conditions which have been demonstated many times in crucible experiments, are reliable indicators for what takes place in commercial melting practice.

Window glass production during the month of June was 1,429,544 boxes, which represents 88 per cent of the industry's capacity. The total production for the six months of 1937 amounted to 6,459,656 boxes, or 66.4 per cent of capacity.

EQUIPMENT AND SUPPLIES

TO MAKE GLASS MACHINERY

The Miller Glass Engineering Co., Columbus, O., was incorporated last November for the design and manufacture of machines and equipment for the formation of glass articles. The company has purchased a one-story building at 144 Glenwood Ave., is installing machinery, and expects to be in production within a month.

Some of the officers of the firm were formerly connected with the Miller Mould and Machine Co., which was sold by Edward Miller to the Lynch Corporation. Florian F. Ergler is president; H. G. Carlisle, vice-president and chief engineer and P. J. Knospe is secretary and treasurer. The three officers, with F. E. Miller and W. Williams form the board of directors.

MATHIESON PROMOTIONS

Several changes have recently been announced by The Mathieson Alkali Works, whose main offices are at 60 East 42nd Street, New York. Robert M. Mannheim has been appointed New England District Manager, with headquarters in the Hospital Trust Building, Providence, R. I. Mr. Mannheim has been a member of the Mathieson organization for the past six years and until recently covered the northern New Jersey territory.

James R. Harrington, in charge of the New York metropolitan area, will take over Mr. Mannheim's old territory in northern New Jersey, while Donald G. Ross will replace Mr. Harrington in the New York area. Mr. Harrington is a graduate of Washington University, St. Louis, Mo. and a former member of the Titanium Division of National Lead Company. Mr. Ross received his training at Princeton University and has been until recently a member of Mathieson's New York Office staff.

ZIRCON

The Titanium Alloy Manufacturing Company, Niagara Falls, is now offering comparatively pure zircon in the granular and milled classifications. These are of the following analysis:

TAM Grain Zircon	Granular	Milled
ZrO_2	64	63
SiO_2	35	36
TiO_2	0.30–	0.30–
Fe_2O_3	0.01–	0.01–
Rare Earths—		
La_2O_3, CeO_2, etc.	0.20	0.20
CaO and MgO	0.30	0.30
Na_2O	0.02	0.02
P_2O_5	0.15	0.15

HOW TO RUN A LATHE

The 33rd edition of the well-known machinists' manual, "How to Run a Lathe", has recently been announced by its publisher, The South Bend Lathe Works, South Bend, Indiana. The new edition has 160 pages containing the latest and most authoritative information obtainable about the fundamental operations of modern lathe practice. Instructions on every phase of lathe work are given in detail in easily understandable language and accompanied with more than 300 illustrations.

Besides dealing with all types of lathe work, the book includes much useful shop information of a general nature, such as reference tables and formulae, tables of cutting speeds of metals, application of lathe tools, cutting screw threads, metric screw threads, taper turning and boring, milling and keyway cutting, bushing work, gear cutting, proper application and types of drives, shop hints and short cuts.

Copies are priced at 25c each, and will be mailed postpaid anywhere on request to THE GLASS INDUSTRY.

FORM GAYLORD CORPORATION

Announcement has been made of the completion of the consolidation of Robert Gaylord, Inc., and Bogalusa Paper Co., Inc., to form the Gaylord Container Corporation, with principal offices in St. Louis. This brings together in corporate form, without change in personnel or policies, two organizations that have long been closely associated. It combines the pulp, board and paper mill properties of Bogalusa with the large converting and selling facilities of Robert Gaylord, Inc., in the corrugated and solid fibre shipping container, folding carton and bag fields.

A NEW INSULATOR

A new synthetic insulating compound has been recently introduced by the General Electric Company under the trade name Flamenol. While similar to rubber in its characteristics, it contains no rubber and will not support combustion. In addition, it is highly resistant to moisture, acids, alkalies, and oils. The manufacturer claims excellent aging characteristics and mechanical strength.

The properties of Flamenol are such that it can be made a very soft and flexible compound, or one with celluloid-like rigidity. It can be put into solution for coating or impregnating, and can be compounded, filled, calendered, etc., the same as rubber.

A MOTORIZED DECORATING SERVICE

A new color service has been announced recently by the B. F. Drakenfeld Company, of New York and Washington, Pa. Late in June, the company put into active commission a motorized laboratory, illustrated here—a handsome aluminum trailer in which is contained a complete color matching unit. The trailer is now making a tour of every glass plant east of the Mississippi. If it has not yet visited your plant, one of these fine days you will see this magnificent entourage parked in your lot. Then, if you have been having trouble matching colors, or trying in vain to achieve some very particular color effect, the Drakenfeld expert will do the job for you on the spot; for right inside the trailer he has all the equipment for weighing ingredients, milling, spraying and firing. When the expert has worked out the answer to your problem, he'll give you a sample of the finished job, with formula and instructions—and be off to the next plant.

TheHarbison-Walker Refractories Company, Pittsburgh, has announced further improvement in the refractoriness and working quality of *Harwaco Bond*, a high temperature bonding mortar for use in industrial furnace masonry.

As the result of several years research it is claimed that this mortar, having a Pyrometic Cone Equivalent of Cone 32 (3092 F.), will maintain a strong bond between fireclay or high alumina bricks at the upper limits of furnace operating temperatures. Also the mortar remains soft and plastic, until ready for use.

General Refractories Company announce the appointment of the Tennessee Mill & Mine Supply Co., Knoxville, Tennessee, as Distributor in the Knoxville area. Tennessee Mill & Mine Supply Co. will carry a complete stock of refractories.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	42.00	45.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.021	.0255-.028
Powdered	In bags, lb.	.0235	.028-.0305
Boric acid (H_3BO_3) granulated	In bags, lb.	.0475	.0525-.055
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07⅛
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	.08½	.09
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	31.50	....
In bags	ton	33.10	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.085	....
In 5 Ton lots	lb.	....	.09
Less than 5 Tons	lb.	....	.095
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	....
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	....
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065-.0675	.07⅜
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.25-2.65
95% and 97%			
Bulk	Per 100 lb.	1.325	....
200 lb. bags		1.39	1.44
100 lb. bags		1.425	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	....	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	....	.15½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03¾
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	.07¼
Rutile (TiO_2) powdered, 95%	lb.	.11-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.06¾	.06¾
Tin Oxide (SnO_2) in bbls	lb.	....	.60
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .005-.02c higher)		.07	.07½-.08
Commercial, Gran. (Milled .005-.02c higher)		.03	.04-.05

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.50-1.75
(Commercial. 25% Selenium)	lb.	....	.90
Cadmium sulphide (CdS)	lb.	....	1.50-155
Chromite	lb.	....	.0215
Cerium hydrate			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.21-.26
Cobalt oxide (Co_2O_3)			
In bbls	lb.	....	1.67
In 10 lb. tins	lb.	....	1.77
Copper oxide			
Red (Cu_2O)	lb.	....	.20¼
Black (CuO)	lb.	....	.18½-20¼
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425
Black (Fe_3O_4)	lb.	.04½	....
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$)	lb.	....	.16
Manganese, Black Oxide			
In Paper bags	ton	55.00	58.00-63.00
In Burlap bags	ton	57.00	60.00-65.00
In Casks	ton	59.00	63.00-67.00
Neodymium oxalate, 50 lb. drums	lb.	....	3.00
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	....	.09
Powdered	lb.	.09⅛	.09½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.18¾-.19¾
Rare earth hydrate			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	2.00
In lesser quantities	lb.	....	2.10
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06⅝	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	....	.08⅜
Sodium selenite (Na_2SeO_3)	lb.	....	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.50-1.55
Yellow	lb.	....	1.50-1.55
Sodium uranyl carbonate	lb.	....	.80-.90
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.25
Yellow orange	lb.	....	1.50

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	....	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1	lb.	....	.03¾
Putty Powder	lb.	....	.38-.42
Rotten Stone	lb.	....	.03
Rouge, Red	lb.	....	.14
Black	lb.	....	.16

A.S.T.M. ORGANIZES COMMITTEES FOR GLASS

Nearly 30 members of the American Society for Testing Materials held their 40th annual meeting in New York City the week of June 28 for the purpose of formally organizing a new committee on glass and glass products which is to be known as A.S.T.M. Committee C-14. The scope of this new committee was defined as, "the development of nomenclature and methods for analysis and testing of glass, both as such and as specific products."

After the adoption of the by-laws, the following officers and members of the advisory committee were elected for the year 1937-1938: Chairman, G. W. Morey, Geophysical Laboratory, Washington, D. C.; Vice-Chairman, F. C. Flint, Hazel-Atlas Glass Co., Zanesville, Ohio; Secretary, Louis Navias, General Electric Co., Schenectady, N. Y.; Advisory Committee, J. C. Hostetter, Hartford-Empire Co., Hartford, Conn., J. T. Littleton, Corning Glass Co., Corning, N. Y., A. N. Finn, National Bureau of Standards, Washington, D. C., and G. M. Rapp, New York Port Authority, New York City.

The chairman, Dr. Morey, then briefly outlined the tentative plans of the committee and announced the formation of the following sub-committees and their chairmen: I—Nomenclature and Definitions, G. W. Morey; II—Chemical Analysis, G. E. F. Lundell; III—Chemical Properties, D. E. Sharp; IV—Physical and Mechanical Properties, J. T. Littleton; V—Thermal Properties, E. W. Tillotson; VI—Glass Construction Block and Tile, J. P. Staples.

The chairman of each sub-committee then outlined the tentative plans for their respective committee. At present, sub-committee I plans to devote its work to the definition of that much mooted question "What is Glass." As Dr. Lundell was absent from the morning session the work of sub-committee II was not announced but it is believed that it will concern itself with the development of a new standard sample of soda-lime glass. Sub-committee III plans to first work on the development of a suitable standard method for determining the durability of glass as glass. Methods for determining the durability of glass in the form of products will be postponed until the "glass as glass" method has been completed. The details covering this standard durability method will be fully discussed at a future meeting of this committee.

As A.S.T.M. Committee D-9 has been investigating some of the physical and mechanical properties of glass this part of the D-9 activities will be turned over to sub-committee IV of C-14. In addition to continuing the work on tensile strength now in progress, sub-committee IV will also investigate the subject of the thermal endurance of glass in addition to other physical and mechanical properties. It is believed that the work on thermal endurance may become important enough to warrant the formation of an additional sub-committee at some future date.

Sub-committee V will deal with thermal conductivity, specific heat and other thermal properties of glass.

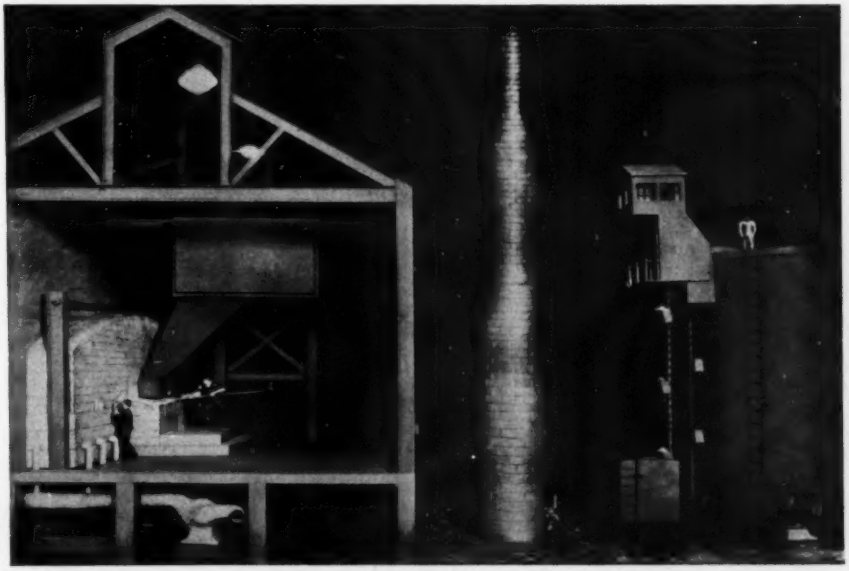
Sub-committee VI will at present, attempt to gather together all available information regarding properties of, and methods of using glass block and tile.

NOTES ON JAPANESE GLASS ACTIVITIES

● The Tokunaga Glass Company of Osaka recently announced a figured sheet glass which it claims to be the thinnest and strongest ever produced by any factory in the world. In a breaking test made under specified conditions a reference piece of 2 mm. thickness was ascertained to withstand a maximum load of 4.0 kilograms against only 3.5 kilograms for ordinary plain sheet glass of the same thickness. The impact strength, measured with a 100-gram steel ball released from varying heights, proved 100 per cent higher than that of ordinary 2 mm. sheet glass.

The glass is said to contain greater quantities of silica, alumina and magnesia than does any other figured glass on the market. Its iron content is 0.05 per cent on the average, and 0.07 per cent at the most. This is claimed to be the lowest iron content ever attained on an industrial scale.

Besides the 2-mm. grade the firm offers 4 and 6-mm.



● *The unloading and storing of raw materials, the preparation of batch and the charging of the furnace as depicted in the Owens-Illinois diorama at the Great Lakes Exposition, Cleveland.*

sheets. Figured glass has a considerable market in Japan, where it is widely used in glazing sliding doors and windows.

• The demand for bottles in Japan is governed largely by the production of beer. About 98 per cent of all Japanese beer is distributed in bottles of liter capacity.

NEW PROCESS FOR MIXING OXIDES

• A new method of mixing sodium carbonate and Glauber's salt (the crystalline form of sodium sulphate) to batches for sheet glass manufacture has been developed by Messrs Akiyama, Miyazaki and Matsuo, engineers of the Asahi Glass Co. "By employing this method," the company is quoted as saying in the *Nikkan Kogyo Shimbun* (*Industrial Daily News*), "not only a sheet glass of superior quality is obtained but also the production cost is reduced to no small degree."

The shortcomings inherent in the use of these two materials as sources for basic oxides are said to be the difficulty in dehydrating Glauber's salt and the tendency of the sodium carbonate to separate out during the mixing process owing to its powdery structure.

In the new process the two materials are mixed at an equal ratio and treated in such a manner that the sodium carbonate absorbs the crystalline water of the Glauber's salt, so that at the same time both chemicals lose their original physical characteristics. After this mixture has been further dehydrated by heat treatment, it is added to the batch.

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SUPPLIERS OF ALL CERAMIC NEEDS
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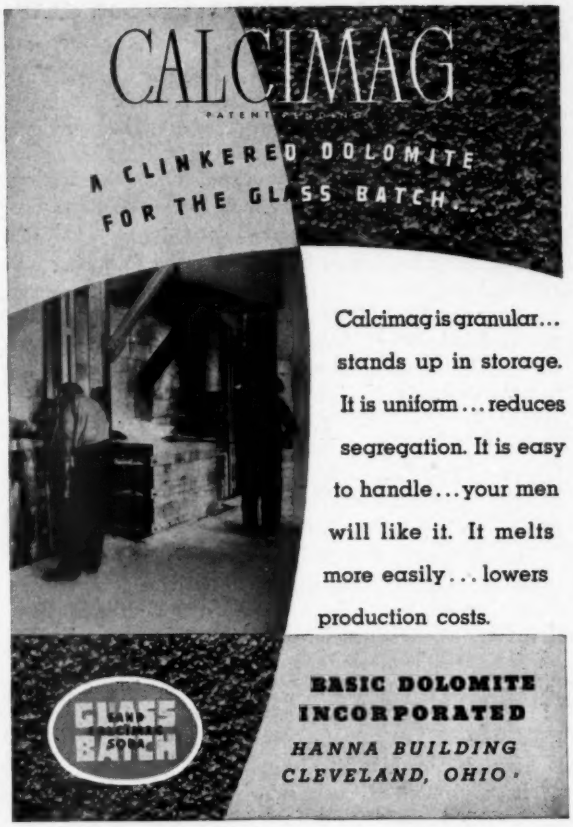
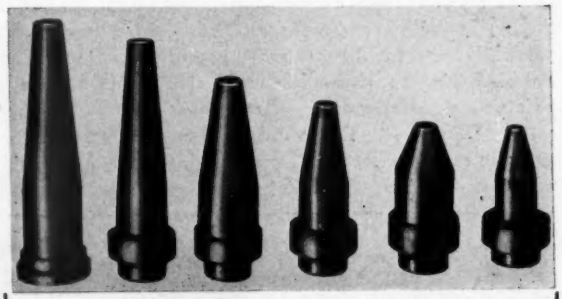

CALCIMAG
A CLINKERED DOLOMITE
FOR THE GLASS BATCH
Calcimag is granular... stands up in storage. It is uniform... reduces segregation. It is easy to handle... your men will like it. It melts more easily... lowers production costs.
GLASS BATCH
BASIC DOLOMITE INCORPORATED
HANNA BUILDING
CLEVELAND, OHIO



GUNITE MALLEABLE RODS

because of extreme ductility and excellent resistance to wear, have won wide acceptance among glass manufacturers for mould plugging. Stock sizes 3/16-1/4-5/16-3/8 . . . 6 inches long.

GUNITE ROUND STICKS

Resistance to fatigue, elasticity and high thermoconductivity make Gunite the most desirable metal for glass mould parts. Gunite Round Sticks for bushing, sleeves, plungers, etc., are available in sizes from 3/4" up. Send for details and prices.

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ESTABLISHED 1854